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UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

AUTOMATIC POWER RELEASES FOR SHUTTING OFF POWER FROM MINE AND INDICATING BY SIGNAL ALARM WHEN FAN STOPS OR DOORS ARE LEFT OPEN

BY

W. J. FENE AND R. F. DALRYMPLE

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Ventilation is undoubtedly the greatest single safety factor in the operation of a coal mine. Any occurrence that interrupts the ventilating current or changes its normal course through the mine workings is a distinct hazard and should be considered as such by every coal-mine owner and operator. The hazard, of course, is much greater in a mine that is producing gas, as an explosive mixture can accumulate in a very short period if the ventilating current is interrupted. It is relatively common to find one or more entries producing 600 cu. ft. or more of methane per hour. If the ventilating current were short-circuited from these entries for 15 minutes, there would be an average accumulation of 150 cu. ft. of methane, which, when mixed with enough air to dilute it to the lowest explosive point, would make about 3,000 cu. ft. of explosive mixture. This body of gas could easily be ignited, in any mine that uses electricity as a source of power, by a cutting machine or other electrical apparatus. This gas in turn might propagate an explosion of coal dust that could completely wreck the underground workings and possibly some of the surface structures.

The possibility of occurrence of the above condition has received comparatively little consideration from the mine owners and operators in some parts of the United States. It is believed that this should be considered a distinct hazard and steps taken to prevent it from happening.

If the ventilating fan should stop and an accumulation of explosive gas result, manifestly it would be impossible to ignite it by electrical power transmitted from outside of the mine if such power were cut off at the surface.

At some mines the power is cut off by an attendant on the surface when he observes that the fan has stopped, but this method is by no means dependable or positive. This method would be very satisfactory if the attendant were always near the fan and the switches controlling the underground circuits opened immediately after the fan stopped. However, the attendant is not always near the fan (frequently the fan has no attendant) and enough time might elapse before he observed that the fan was stopped to allow an accumulation of explosive gas to be ignited before the circuits were opened. A much more satisfactory method has been adopted at some mines - the installation of devices that automatically open the underground circuits when the fan ceases to function or when the ventilating current is reduced to some predetermined velocity.

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[2] - Associate mining engineer, U. S. Bureau of Mines.

[3] - First-aid miner, U. S. Bureau of Mines.

Several different types of power release are in use, four of which are described in detail in this paper. It is believed that a device of this kind or any other device that serves the same purpose should be installed in every mine that produces explosive gas, but it should be installed in such a way as not to interfere with hoists or cages that are used to bring employees to the surface. These hoists or cages should operate from a separate power line. In some States the mining law now makes the use of such devices compulsory.

If the fan should stop and the power should remain off for more than a few minutes, the men in any mine that gives off explosive gas should all be removed from the mine. After the fan has resumed its normal function and has been operating normally for at least a few hours, thorough inspection should be made of all the underground workings before the men are allowed to return to work.

Description of Several Types of Automatic Power Release and Signal

The several types of power release and signal described here depend upon difference in ventilating pressure for their operation. With one type, the release of pressure against a vane operates the contact points, and with the other types the contact points are closed when the air pressure is equalized on two sides of a wall. These devices are simple in design and operation, can be made in most mine machine shops, and are comparatively low in cost.

Figure 1 shows the type of power release and signal used by the Victor American Fuel Co. at its Colorado mines. The device consists of an aluminum vane about 1/32 inch in thickness and approximately 16 by 18 inches in area. The size of the vane will depend upon the velocity of the air in the fan drift where it is to be used. This vane is mounted on a small shaft about 1/2 inch in diameter and is supported between two iron brackets, one on the inside of the fan drift and the other on the opposite side of the wall in the motor room. One end of each bracket is drilled and tapped to hold a brass screw having a hole bored in one end to support the pointed ends of the vane shaft. These brass screws are fitted with lock nuts to hold them in proper adjustment. A paddle arm about 16 inches long, made of 1/4 inch steel or iron rod, is mounted on one end of the vane shaft by means of a set screw or welding to the shaft. On the other end of the paddle arm is a small galvanized sheet-iron paddle about 3-1/2 inches wide and 4 inches long. In this paddle is cut a hole about 1-1/2 by 1-3/4 inches in size, and on one side is hinged a small piece of the same material. This "clapper valve" overlaps the hole in the paddle about 1/4 inch on all sides. The paddle is submerged in oil in a galvanized-iron tank about 4-1/2 inches wide, 5 inches deep, and 18 inches long, ordinary engine oil being suitable, if outside temperatures are not extreme. If there is extreme cold weather this oil can be thinned out with a little kerosene. The function of the oil is to prevent undue movement of the paddle due to slight variations in the ventilation pressure. Two mercury contact tubes are mounted on the face of a fiber disc about 1/2 inch in thickness and approximately 6 inches in diameter, which is keyed or fastened to the vane shaft. Brass clips similar to those used on inclosed fuse blocks may be used to mount the tubes to the disc. These clips are drilled with one hole in the center and are bolted to the fiber disc with about a 1/4 inch stove bolt, which makes a convenient fastening and permits adjustment of the level of the tube to the proper angle,

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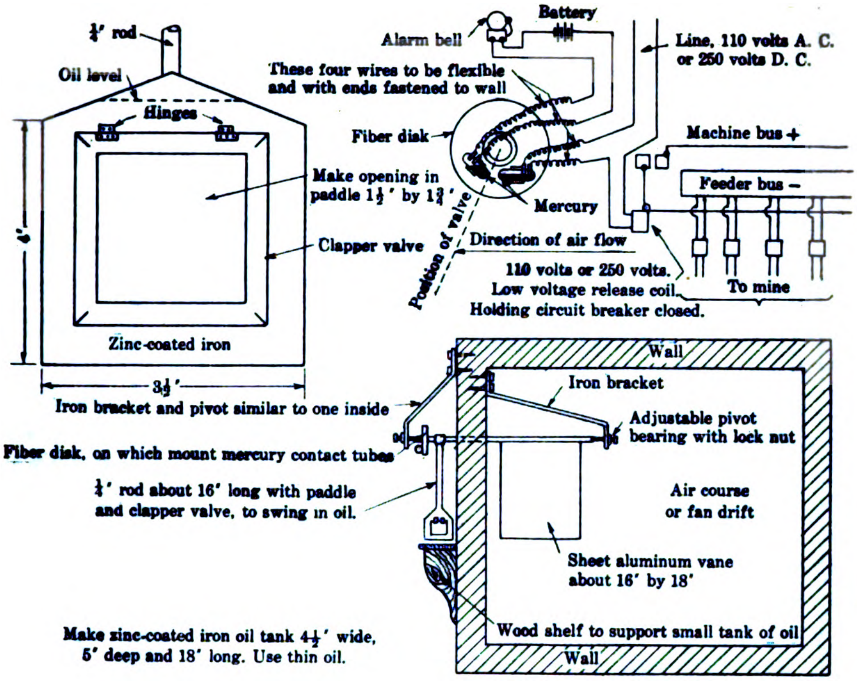
¾' rod
Oil level
Hinges
4'
Make opening in paddle 1½' by 1¾'
Clapper valve
Zinc-coated iron
3½'
Iron bracket and pivot similar to one inside
Fiber disk, on which mount mercury contact tubes
¾' rod about 16' long with paddle and clapper valve, to swing in oil.
Alarm bell
Battery
These four wires to be flexible and with ends fastened to wall
Fiber disk
Mercury
Position of valve
Direction of air flow
Line, 110 volts A. C. or 250 volts D. C.
Machine bus +
Feeder bus −
110 volts or 250 volts. Low voltage release coil. Holding circuit breaker closed.
To mine
Wall
Iron bracket
Adjustable pivot bearing with lock nut
Air course or fan drift
Sheet aluminum vane about 16' by 18'
Wood shelf to support small tank of oil
Wall

Make zinc-coated iron oil tank 4½' wide, 5' deep and 18' long. Use thin oil.

Figure 1. – Automatic power release switch operated by ventilating current

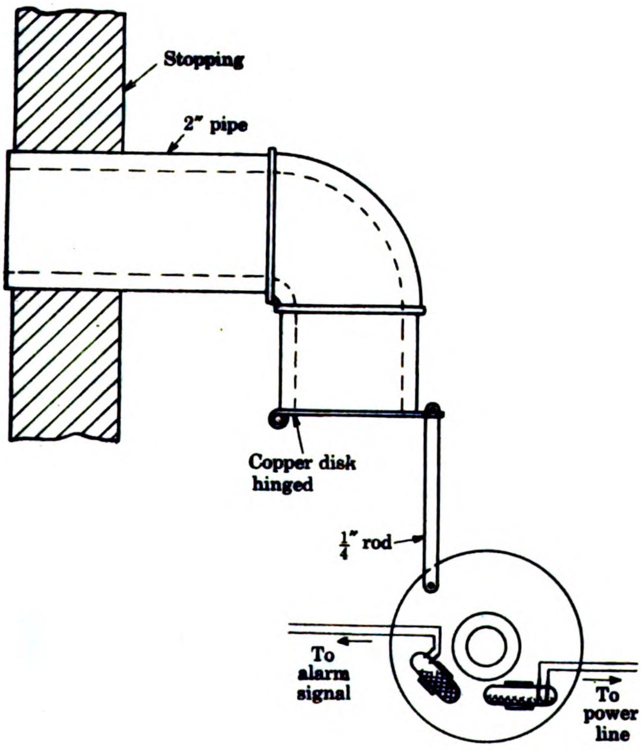

Figure 2. – Cross section of power release used in entry stopping or fan drift

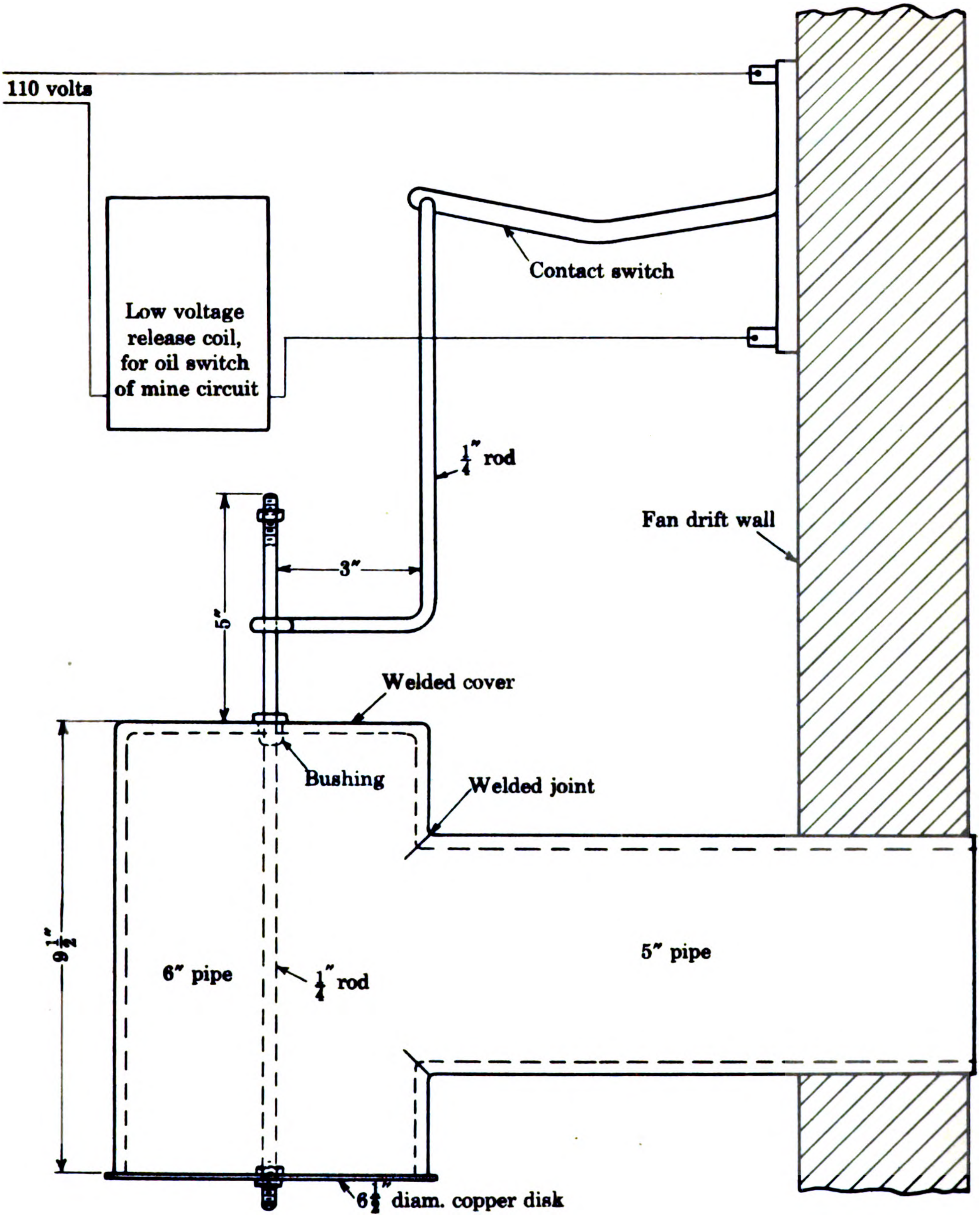

Figure 3. – Cross section of Shaw automatic power release

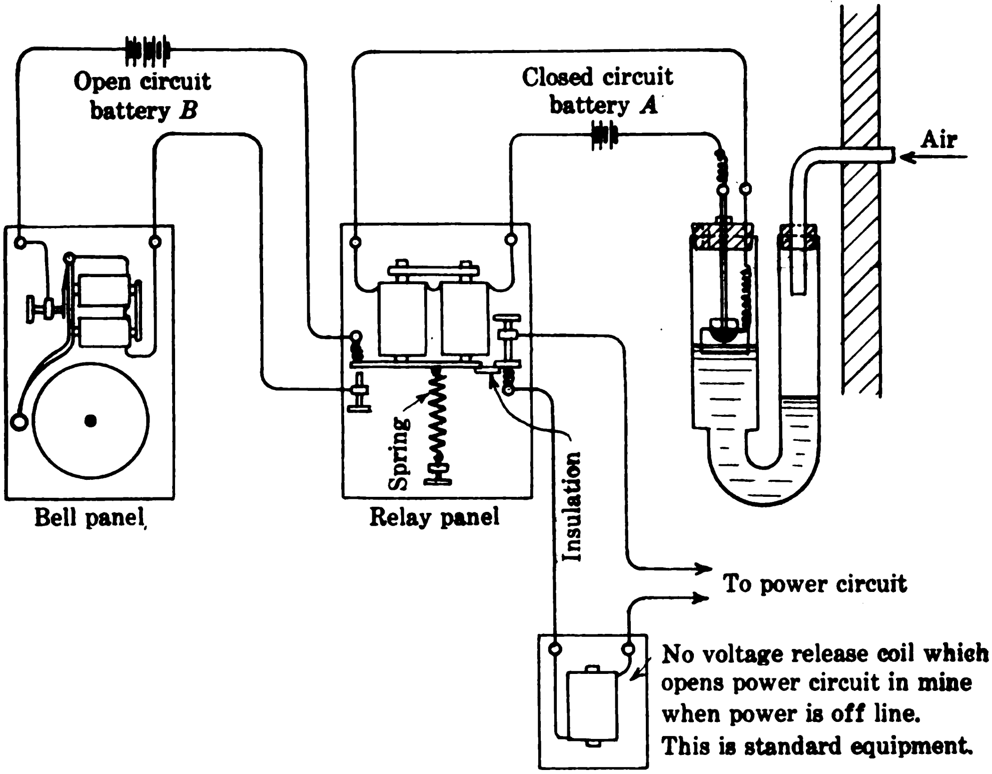
Open circuit battery *B*
Closed circuit battery *A*
Air
Spring
Bell panel
Relay panel
Insulation
To power circuit
No voltage release coil which opens power circuit in mine when power is off line. This is standard equipment.

Figure 4. – Automatic power release and fan signal

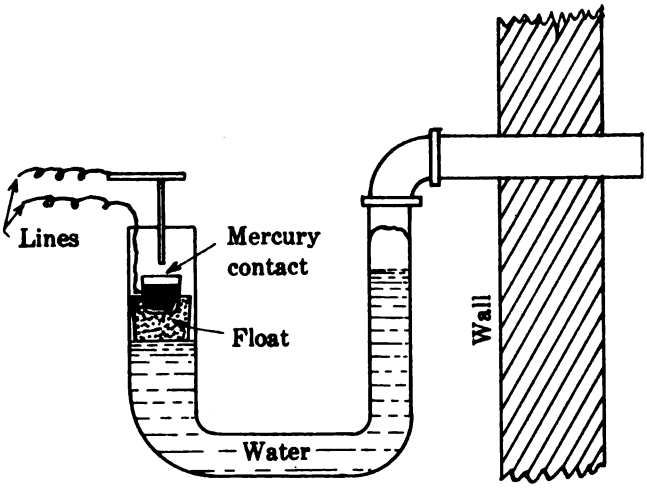

Figure 5. – Automatic fan signal

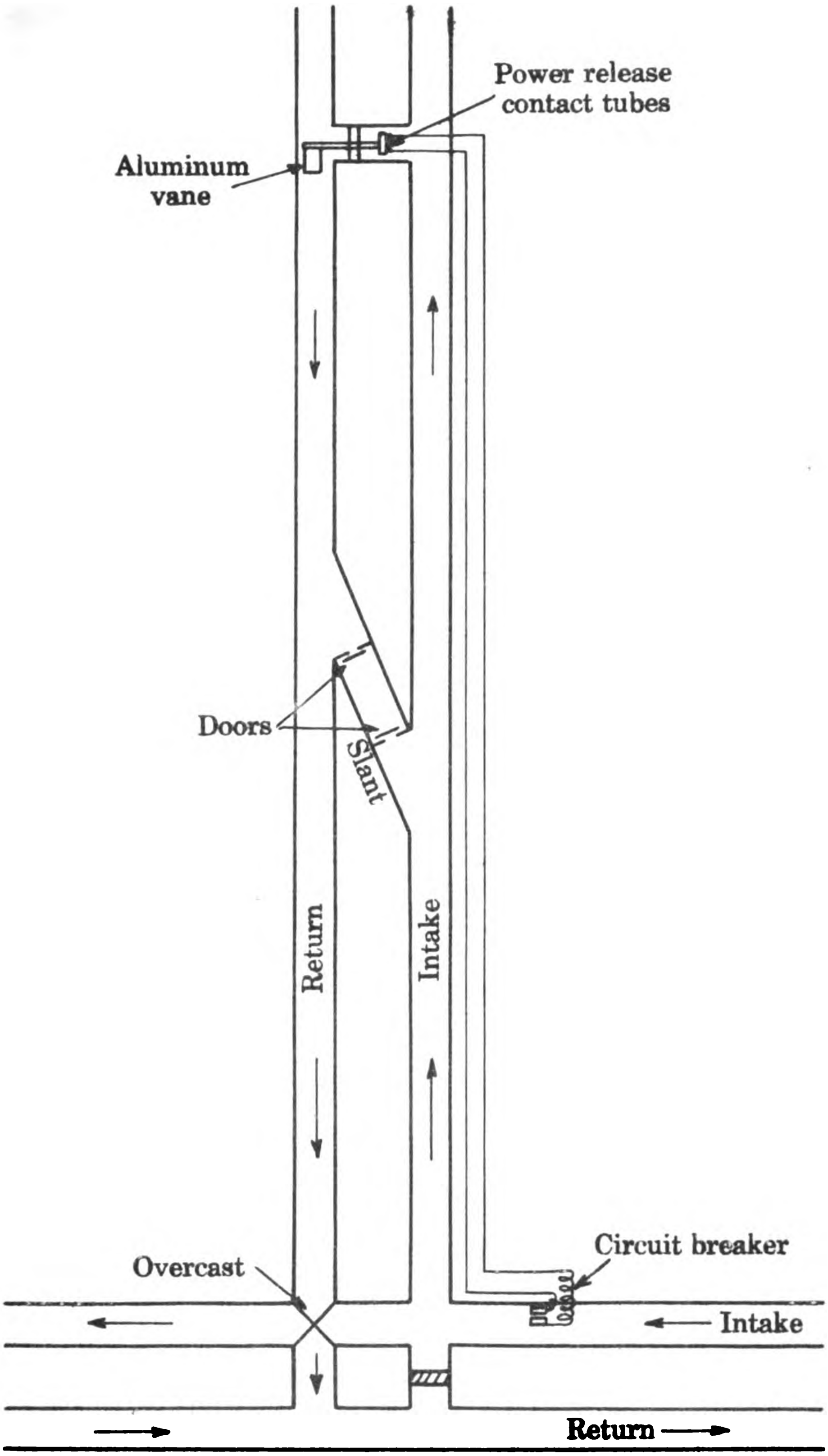

Figure 6. – Plan of power release in an entry or split

so that the contact pieces within the tube are submerged to the proper depth in the mercury when the contacts are closed. The mercury tubes contain a gas that prevents corrosion of the contact points, and as there is no open arc when contact is made there is no danger of ignition of gas that may be present. One tube is used to make and break the current taken from any 110-volt alternating-current or 250-volt direct current lighting circuit. The contacts in this tube are in series, with a low-voltage release coil controlling a circuit breaker inserted between the machine bus bar and the feeder bus bars. The low-voltage release coil, of course, must be wound for the voltage that is to be used through the contact tube. The other tube is so placed that when the vane returns to a vertical position the mercury flows toward the contacts and closes the alarm-bell circuit. This alarm bell can be placed at any location and as many can be used, placed at various points on the property, as are desired. Batteries may be used for this circuit, but alternating-current power and bell transformers can be used as a substitute for batteries.

Figure 2 shows a type of automatic power release and alarm that may be used in an entry stopping or fan drift. It utilizes the effect of the release of suction to operate the mercury contact tubes. This device consists of a 2 inch pipe, long enough to extend through a stopping or wall and about 8 inches to one side. To this pipe is connected an L, the open end of which has been ground to make a tight seat with the light copper disc that is hinged to the lip of the L. Opposite the hinge on the copper disc is fastened a 1/4 inch rod to serve as an arm to move the mercury tubes when suction is released and the copper disc drops. The mercury tubes are mounted similar to that described for the device shown in Figure 1.

Figure 3 shows the type of automatic power release developed and used by the Consumers Mining Co. at its Harmarville (Pa.) mine. The device consists of a piece of 6 inch pipe, 9-1/2 inches long, on one end of which has been welded a piece of iron or steel plate. A 5 inch hole is cut into the side of the 6 inch pipe, into which a 5 inch pipe is welded, forming a T. The length of the 5 inch pipe depends on the thickness of the fan drift wall. A 3/4 inch hole is bored through the plate, previously welded to one end of the 6 inch pipe, and a bushing with a 1/4 inch hole supplied. A 1/4 inch rod about 15 inches long is attached to a copper-sheet disc about 7 inches in diameter. This rod is inserted through the bushing with the copper disc over the open end of the 6 inch pipe. Another 1/4 inch rod bent to form an L is attached to the rod extending through the 6 inch pipe and to the lever arm of a contact switch.

The 5 inch pipe is placed through the wall of the fan drift in the suction side of the fan, about flush with the inner side of the wall. The switch used may be of the contact or float type, which is connected in series with a low-voltage release coil controlling an oil switch for the mine circuit. When the fan is operating the copper disc is held flush against the bottom of the T due to the suction of the air. When the fan stops, the disc will fall of its own weight and throw the switch which operates the low-voltage release coil, which in turn controls the oil switch for the mine circuit.

Figure 4 shows an automatic power release and signal arrangement developed and used by the Colorado Fuel & Iron Co. The arrangement of this device is somewhat similar to the one shown in Figure 1, with the exception that a U-tube is used instead of a vane and a relay panel is used to control the signal bell and open the release coil on the mine power circuit.

The U-tube has one large and one small leg, this being necessary to obtain the maximum travel of the float where small pressures are used, or small travel where the pressure is greater. A float carrying a cup containing mercury, which is covered with transformer oil to extinguish the arc, is placed in one leg of the U-tube. Transformer oil, salt water, glycerine, or any other liquid that will not freeze should be used in the U-tube.

Figure 5 shows a simple arrangement designed to give a signal warning when the fan stops or slows down. The device consists of a U-shaped pipe, a cork float on which is mounted a cup containing mercury, suitable copper contacts, and necessary lead wires. The U-pipe is placed in the wall of the fan house, the U being on the outside with the other end extending into the intake. The U-pipe is filled with salt water, glycerine or any other liquid which will not freeze at temperatures likely to be encountered.

As long as the fan operates at its rated speed, the level of the liquid in the short leg of the U will be pulled down, carrying the cork with it; slowing down or stopping of the fan allows the liquid to rise, making contact with the mercury and copper strip attached to one of the lead wires. The circuit is then completed and the signal bell rings, giving warning that the fan has slowed down or stopped.

Use of Automatic Power Releases and Signals Underground

Numerous explosions have occurred during recent years due to doors having been left open by some one during the working shift but the danger of carelessness is more likely to occur during the night shift; this short-circuiting of the ventilating current allows an explosive mixture of gas to accumulate, and carelessness with electricity or open lights has brought about ignitions with numerous fatalities.

Doors for controlling ventilation should be eliminated in so far as possible, but where they are used they should be protected by a signal and power release device to give warning and to turn off the power from that particular section of the mine when the door has been left open. Any of the devices previously described can be used for that purpose as they are as readily applicable for this service as they are to using them to give warning and to turn the power off the mine when the fan stops.

Figure 6 shows an arrangement of a power release on an entry or split using the device shown in Figure 1. In airways or entries where the vane might interfere with any of the mine activities, any of the U-tube types of power releases may be used. To eliminate the possibility of gas or dust being ignited from the circuit breaker, it should be of the inclosed-oil type and located on the main entry in pure intake air. These underground installations should be adequately protected to prevent damage from falls of roof.

The automatic power releases and signals described herein may be used to an advantage at any gassy mine. Aside from being a factor of safety in releasing the power and giving warning when the fan stops running or a door is left open, at many mines the use of a fan attendant may be eliminated.

These devices are not manufactured for sale. However, they are simple in design and installation and can be made in most mine machine shops.